

^ ∪ ∃ ⊕ ⊖ , ∃ ⊕ ∨

Standards Converter for Mechanical Television

Model's SCM

User and Technical Manual

Copyright 2006-12 Aurora Design LLC.
Revision 4.0
2 October, 2012
All specifications subject to change
www.tech-retro.com

Introduction

This manual covers the operation and technical aspects of the Single-Standard Converter for mechanical television. The Converter is designed to accept an NTSC or PAL/SECAM video signal and convert to one of several different output standards. The converted video is sent to a composite video output connector.

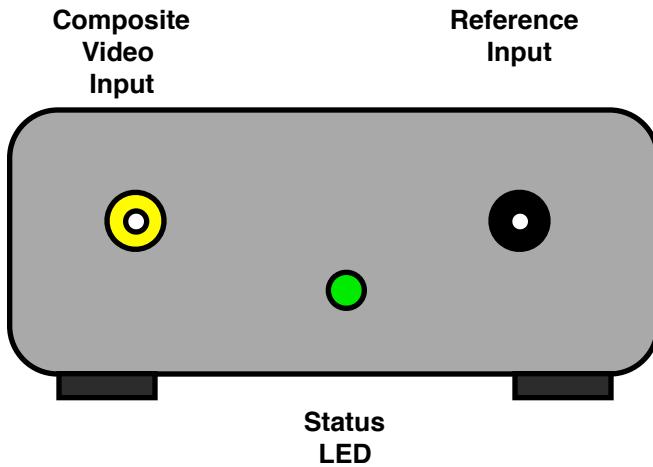
Due to the nature of mechanical television it is assumed that the user has a good understanding of what is required to operate such a device in conjunction with this converter, such as an appropriate lamp (Neon, LED, etc.) and a lamp driver that accepts the video output signal from this converter. No attempt is made in this document to describe such a driver and its operation.

Features

- Compact, low power, surface mount design
- Front panel tri-color Status LED
- Up to 16 user programmable options
- Extremely stable output: +/- 3% levels
- 10 bit video D/A for greater than 54dB dynamic range
- 250K gate equivalent FieldProgrammableGateArray
- 8Mb FLASH memory for FPGA firmware, user parameters and default image
- Automatic Sleep Mode for low power standby operation
- Reference Input allows synchronization to external source
- Extremely accurate algorithms used for conversions
- Full three frame memory for stable output regardless of input
- Versatile I/O:
 - Composite Video Input (NTSC/PAL, 1Vpp, 75 ohm)
 - Video Output (various standards, 1Vpp, 75 ohm)
 - Reference Input (+/-30V, 20K ohm, ZeroCrossingDetector)
 - Current Driver Output (333ma maximum) (optional)
 - DC power (7-14Vdc, 200ma)

Front Panel

The front panel is shown below:



Composite Video Input:

The Composite video input signal is supplied to this RCA or BNC connector and needs to conform to the NTSC or PAL/SECAM video standards. The unit automatically detects which type of signal is connected and no user intervention is required. For complete information about the characteristics of this input, please refer to the *Specifications* section found later in this manual.

Status LED:

The tri-color status LED conveys the current operating state of the converter.

Solid Red: No video or reference signal detected. Default image displayed.

Solid Yellow: Converter locked to video or reference input.

Solid Green: Converter locked to video and reference input.

Slow Flashing: Options setting mode.
Red: Option Disabled
Green: Option Enabled
Yellow: Option Not Available

Pulsating Red: Converter in low power Sleep mode.

Fast Flashing: Converter Storing default image to internal FLASH.
Yellow or Green

Alternating: Thermal overload on optional Current Driver output.
Red and Green:

Reference Input:

The Reference Input is required for use with certain standards, but is available on all standards. There were two main methods of synchronization used in early mechanical television, one filtered a portion of the video signal and fed it to phonic coils on the television. This method was used when viewing over great distances since the transmitter and receiver were not expected to be on the same AC Mains grid. The other method assumed the AC motor at the transmitter and receiver were powered by the same AC Mains grid, so were inherently in sync. It is for this type of setup the Reference input is mainly used.

One of three different frequencies can be used with all standards; a 50Hz Mains reference, a 60Hz Mains reference, or a frame reference. The frame reference must correspond to the frequency for the selected standard as shown in the Appendix: *Support Output Standards*. For instance, the 45/15-3i Western standard will only accept a 15 Hz frame reference pulse in addition to the two Mains frequencies. The supplied signal to this input must be within +/-4% of the shown value or the unit will not lock to it. The input is an edge sensitive, zero crossing detector, so the actual shape of the signal is irrelevant as long as the selected edge to edge timing is fairly stable. The converter will filter out high band noise, but low, in band frequencies may cause the converter to “hunt”, with the typical back and forth motion of the image. If this occurs, either a cleaner reference signal is required, or the user can change the Reference Fast Tracking option discussed later. The polarity of the edge

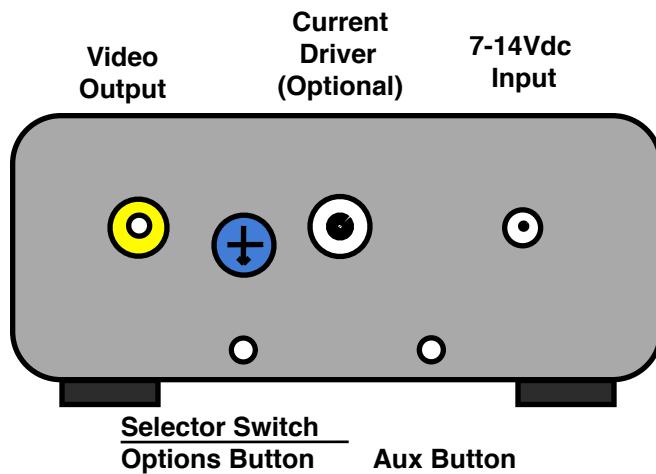
Introduction

used is also selectable by the user as discussed later. The input can withstand up to a +/-30V maximum signal without damage.

This signal will usually be provided by a small AC transformer, typically 6-12Vac, plugged into the same Mains outlet as the television, or from a frame reference signal supplied by some modern experimental mechanical televisions.

Rear Panel

The rear panel is shown below:



Video Output:

This RCA or BNC connector provides the video output from the converter. This output should terminate into a 75 ohm load. For complete information about the characteristics of this output, please refer to the *Specifications* section found later in this manual.

Selector Switch:

The dual purpose Selector Switch is used to select the output standard and to select the user option during options programming.

During normal operation, the Selector Switch selects the Output Standard of the video output. The specific Output Standard for each position can be found on the

bottom label of the converter, and in the *Supported Output Standards* section found later in this manual. This control is adjusted by inserting a small flat blade or phillips screw driver into the hole, and engaging the slots in the switch.

If the Option Button is pressed (see below), the current Output Standard is frozen, and the Selector Switch is used to select the desired user programmable option.

Options Button:

This pushbutton is used to enter the Options Setting Mode and to change the state of the User Options. The button can be depressed by inserting a paper clip, or other small tool into the hole in the back of the unit. When the Option Button is depressed for 1 second, the unit enters the Option Setting Mode and freezes the currently selected Output Standard. By using the Selector Switch, you can choose the desired option position. The front panel Status LED will blink green if the option is enabled, red if the option is disabled, and yellow if the option is not supported. When the desired User Option is chosen using the Selector Switch, the Option Button is pressed momentarily to toggle the option between enabled and disabled. Each option can be programmed in this manner. When finished, the Option Button is once again depressed for 1 second to exit the Option Setting Mode. Also if no changes of the Selector Switch or Option Button are detected for 1 minute, the unit will automatically exit the Options Setting Mode and return to normal operation.

When the unit returns the normal operation, the Selector Switch may need to be returned to the desired Output Standard.

Current Driver (optional):

This connector provides a Current Driver output from the converter. This output is suitable for direct connection to an LED lamp such as the NEL-1M. It is thermally and short circuit protected. If the output does go into thermal overload, the front panel Status LED will indicate this, and the unit will return to normal operation once the temperature has returned to an acceptable level. For complete information about the characteristics of this output, please refer to the *Specifications* section found later in this manual.

Auxiliary Button:

The Auxiliary Button is used to frame the image on the television and to store the user default image.

While most mechanical televisions provide some means to align the scan lines, many do not offer such ability for frame alignment. By momentarily depressing this button, the image will move down by one line. By holding this button down for 1/2 seconds, the image will move up by one line.

To store a default image the converter must be in it's normal operating mode, with a valid video input connected, and a solid yellow or green Status LED. If a valid video input is not connected, an image cannot be stored. With a stable, stationary video input applied, the Auxiliary Button may be pressed and held for 4 seconds. The Status LED will begin to flash yellow or green quickly, indicating storing of the image FLASH is taking place. This process can take up to 10 seconds, and the video signal must not be disturbed during this process. After the image is stored, the Status LED will return to solid yellow or green.

Once an image is stored, whenever there is no video input connected to the unit, the default image stored in the FLASH may be outputted. (user option to select between this image and the built-in test pattern)

Caution! Because of the nature of the partial-field memory contained in this unit, the default image is stored in bands of several lines at a time. If the connected video is not stationary during the storing process, the resulting image will be distorted. The best way to provide a stationary image for storing is to use the output from a computer video card, or a DVD/PVR player in pause. A typical VCR without a TBC in pause is not suitable for this use.

Power:

The converter requires a power source of between 7.0 and 14 volts DC at 200 mA. A 9 volt DC power supply is recommended to reduce power consumption. (12Vdc is recommended when driving a NEL-1M lamp from the optional Current Driver) Voltages over 16 volts will damage the unit. The unit has a reverse polarity diode in series with the input, so it will not be damaged by reversal of polarity. The

unit uses a standard 2.1mm X 5.5mm, center positive, coaxial power connector as found on most consumer electronic equipment.

User Options

As previously outlined, using a small tool such as a paper clip, carefully press the Options Button for 1 second. This will place the unit into the Options Setting Mode. Next choose the desired option using the Selector Switch. The front panel Status LED will blink green if the option is enabled, red if it is disabled, and yellow if not supported. To change the state of the option, momentarily depress the Options Button to toggle between enabled and disabled. When all desired options are set, again depress the Option Button for 1 second to exit the Options Setting Mode. Also the unit will automatically return to normal operation if the Selector Switch and Option Button are not changed for 1 minute.

Note: Be sure to return the Selector Switch to the desired Output Standard setting after changing the User Options.

Position 0 - Sleep:

This option is used to disable the automatic Sleep Mode. When Enabled the Sleep Mode will force the unit and it's output into a low power state if no video input is detected for 1 hour. When Disabled the unit will never go to sleep.

Position 1 - Gamma

This option is used to select the output mode of the converter between gamma corrected and straight video. Since modern video is pre-corrected at the source to compensate for the gamma of CRT's, and since most lamps used for mechanical television are linear (Neon, LED, etc.) gamma correction needs to be provided to correct the video. This feature performs the correction accurately in the converter so it is not required in the lamp driver. When Enabled, gamma correction will be added to the output. When Disabled straight video will be output, and gamma correction will need to be provided externally. This option should normally be set to Enabled.

Position 2 - Invert

This option is used to select the output mode of the converter between normal and inverted. When Disabled the converter will output a positive video signal. When Enabled the converter will invert the output. This can be useful to match the polarity of an external lamp driver. This option should normally be set to Disabled.

Position 3 - Default Image Select

This option is used to select the default image that is displayed when no video input is present. When Disabled the built-in test pattern is displayed. When Enabled the user stored image is displayed. (Note: the unit is shipped with no user default image stored)

Position 4 - Edge Rate Control:

This option is used to control the Edge Rate of the output video. Since modern electronics are capable of extremely high frequency operation, and all of these early mechanical formats were of very low bandwidth, this option can better match the output bandwidth to that of the Output Standard. When Enabled, this option will control the Edge Rate of the Video Output to limit it's bandwidth to that of just higher than the Output Standard. When Disabled, no limiting is performed on the Video Output, and it will contain extremely high frequencies. This option should normally be set to Enabled.

Position 5 - Frame Buffer Count:

This option is used to select between 3 frame buffers and 1 frame buffer. When Enable, three frame buffers will be used. In this mode the output video image will always be complete, but fast motion in the video may be jerky or not smooth do to the difference in frame rates between the input video and output video. When Disabled only one frame buffer is used which will provide smoother looking images

in the output, but images that may have tearing on fast motion. For still or slowly moving images both modes will look exactly the same on the output. For more information about the this option, please refer to the *Theory of Operation* section found later in this manual. This option should be put into the mode the user finds yields the best image quality.

Position 6 - Black Level:

This option is used to control the Black Level in the output video. Some mechanical standards like 32/12.5p NBTV have black level set at 30% with peak white at 100%, while most other standards have black at 0% with peak white at 100%. This makes it difficult for a lamp driver since the black level and range are different for the various standards. To elevate this condition, this option can be Enabled which will force all standards to use 30% for black and 100% for peak white making it easier for the lamp driver. When Disabled this option will ouput the standards normally. This option should be set to Disabled for normal use, and must be set to Enabled when using the optional internal Current Driver.

Position 7 - Reverse Line:

This option is used to reverse the direction of the scan lines when Enabled. For instance the normal direction for the 45/15_31 Western is right to left, so this will force left to right scanning. 60/20p is left to right so this will force right to left scanning. When Disabled the scan lines will be in the normal direction for the Output Standard. This can be useful if the television motor operates in the wrong direction, or the viewing window is on a different part of the wheel, etc. This option should normally be set to Disabled.

Position 8 - Reverse Frame:

This option is used to reverse the scan direction of the frames. When Enabled this option will reverse the normal scan direction of a frame. For instance the normal direction for the 45/15-3i Western is top to bottom, so this will force bottom to top

scanning. 30/12.5 Baird is bottom to top so this will force top to bottom scanning. When Disabled the frames will be in the normal direction for the Output Standard. This can be useful if the television motor operates in the wrong direction, or the viewing window is on a different part of the wheel, etc. This option should normally be set to Disabled.

Position 9 - Reference Edge Polarity:

This option is used to control which edge the Reference Input Zero-Crossing-Detector will use. When Enable, the positive going edge will be used, When Disabled the negative going edge will be used. For most applications this is not important, but may be useful to the experimenter.

Position A - Reference Fast Tracking:

This option is used to control the loop speed of the Reference Digital-Phase-Locked-Loop used to synchronize the Video Output to the Reference Input. When Enabled, the converter will lock faster, and track closer to the Reference Input signal. This can be good and bad. If the Reference Input contains a lot of jitter or other errors, the converter will more likely track those errors in this mode, and possibly even make them worse due to overall system damping. This may result in an image that hunts along the line direction trying to keep up with the Reference signal. It can be useful however for the experimenter using modern electronics in their mechanical television. When Disabled the unit will take twice as long to lock but will provide a more damped, and more stable lock. This option should normally be set to Disabled.

Position B - Reference Hold:

This option is used to control the behavior of the Reference Digital-Phase-Locked-Loop used to synchronize the Video Output to the Reference Input when no reference is detected. When Enabled, the Digital-Phase-Locked-Loop will hold the

last valid value until a new reference signal is detected or the output standard is changed. When Disabled, the Digital-Phase-Locked-Loop will always return to its nominal setting when no reference signal is detected. This option should normally be set to Enabled.

Operating Modes

Normal Full Operating Mode, no Reference:

When valid video is present the Status LED will show a solid yellow light, and the unit will output converted video on the video output connector. This mode is appropriate for standards that didn't originally use a Reference like the 30/12.5p Baird or the 32/12.5p NBTV.

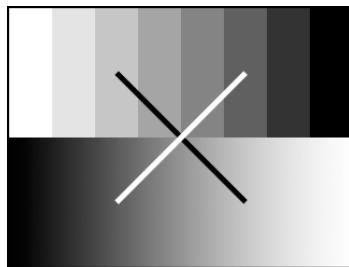
Normal Full Operating Mode, with Reference:

When valid video and an appropriate Reference signal are present, the Status LED will show a solid green light, and the unit will output converted video on the video output connector in sync with the Reference input. This mode is appropriate for standards that used a Reference like the 45/15_3i Western format. These formats typically used a synchronous AC motor to drive the disk, so the converter needs to also be synchronized to the same AC mains source. For complete information about the characteristics of this input and how to use it in a typical application, please refer to the *Typical Connections* section found later in this manual.

Default Image Mode:

When no valid video is connected to the composite input, the converter will output a default image. This can be used to verify operation of the unit, or aid in setup of the television. The image can either be a user stored image or the built-in test pattern. The built-in test pattern consists of an 8 step ramp on the top half of the frame and a linear ramp on the lower half. There is also an “X” in the middle of the

image to help align the image on the television, and find the correct sequence for interlaced standards. The image appears as below:



Sleep Mode:

Since no power switch is supplied on this unit, an automatic Sleep Mode will be entered whenever the video input is not present for more than 1 hour. With this feature, the converter is placed into a low power mode, along with the video output being shut off. Only the video decoder is left active to signal when a valid video input is again supplied to the unit to wake it up.

Typical Connections

In normal usage, a user supplied power adapter is connected to the converter and to the AC power source. A valid NTSC or PAL/SECAM video source will also be connected to the Composite Video input. The video source can be anything from a VCR to a DVD to an off-air broadcast. The video output can then be connected to the input of a user supplied lamp driver, or the output of the optional internal Current Driver can be connected directly to an LED lamp like the NEL-1M. A user supplied driver needs to take the video output signal from the converter and power the desired lamp. (Neon, LED, etc.). The users driver should provide for brightness (level) and contrast (gain) controls to adjust the video signal for proper operation of the lamp. The brightness control can be used to properly setup for blacks while the contrast control can setup for peak whites. (this is not required on the optional internal Current Driver as this is handled automatically)

User options like Gamma and Invert can be adjusted to match what the user supplied lamp driver requires.

Typically some means of synchronization is required for the television to avoid having the user constantly adjust the speed and phase of the motor to keep the image centered and phased. For the NBTV standard, this is done through the insertion of standard type line sync pulses in the video, with the pulse missing on line one for frame synchronization. A properly equipped NBTV television will lock to the output of the converter with no other adjustments necessary. The line and frame phasing should be correct every time the television is operating after initial adjustment.

For televisions like the Baird which used an AC/DC motor and a synchronous phonic coil, the video output signal from the converter needs to be filtered and fed through an amplifier to the phonic coils on the television. This will lock the television to the converter but the user will still need to phase (center) the image.

For televisions that used an AC synchronous motor like the Western Visionette, an AC Mains reference must be connected to the Reference Input on the converter so the converter can lock to the same signal as the motor in the television. In order to accomplish this, a standard 6-12VAC transformer can be used to feed the Reference input. (+/-30V maximum peak) If the signal is noisy, it may be beneficial to filter the signal with a 4.7K resistor and a 0.1uF capacitor. This will filter out much of the high frequency noise.

For the prior two examples, the user will always have to adjust the frame and possibly the line phase every time the television is operated. This is the nature of these types of early mechanical television. There is normally some means provided on the television to accomplish this phasing. Alternatively the user can use the Auxiliary Button on the back of the converter to perform the frame phasing without having to use the television. Each time the Auxiliary Button is momentarily depressed the frame will jump down one line. Each time the Button is held for 1/2 seconds the frame will jump up one line.

If your television is a modern experimental unit with a frame sync output pulse, this can be used to drive the Reference Input of the converter. With this type of system, once the phasing is adjusted, it should never need to be readjusted, and the television should always power up correctly phased.

Since the converter contains three full frames of video memory, the output signal will always be stable regardless of the video input signal. Normally a mechanical television would require relocking and rephasing each time the video input signal changed, but the converter eliminates this entirely. Once the television is locked to the converter, it should remain so indefinitely

Introduction

Due to the nature of standards conversion, frame rate conversion is extremely difficult. This converter provides two different methods of frame rate conversion that can be selected by the user. More can be found out in the *Theory of Operation* section later in this manual.

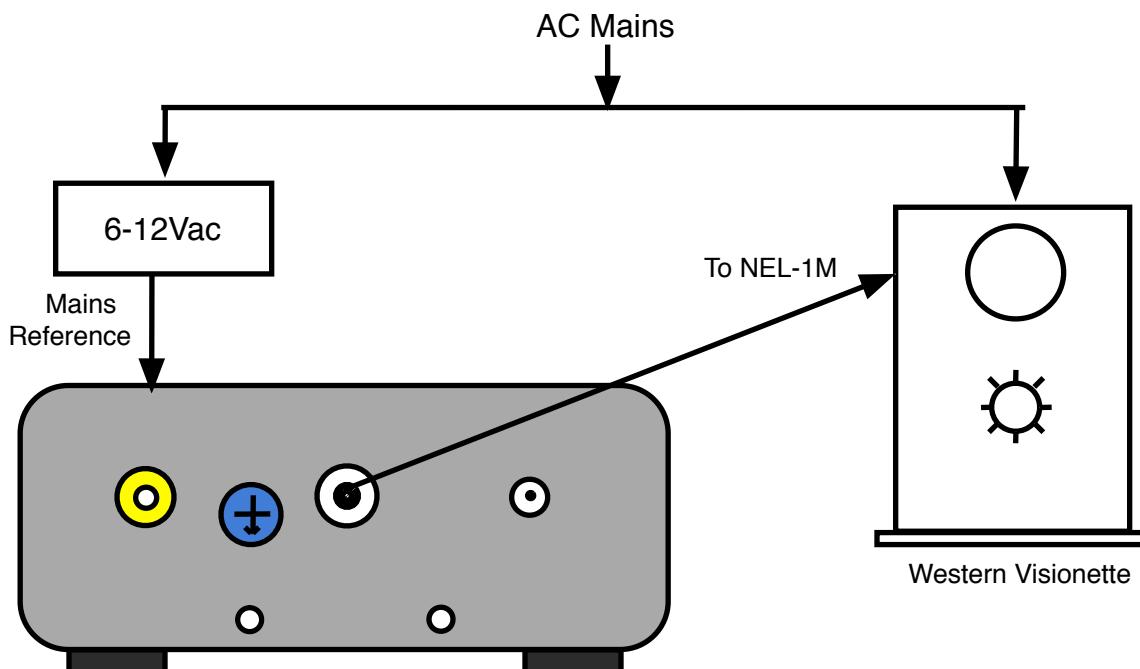
The use of high quality video cables is recommended for best results. Cables conforming to 75 ohm impedance should be used on the video inputs and outputs.

If all the above steps have been properly performed, there should now be a solid yellow or green status light on the front panel of the converter indicating a locked video signal as described previously, and a stable image on the television.

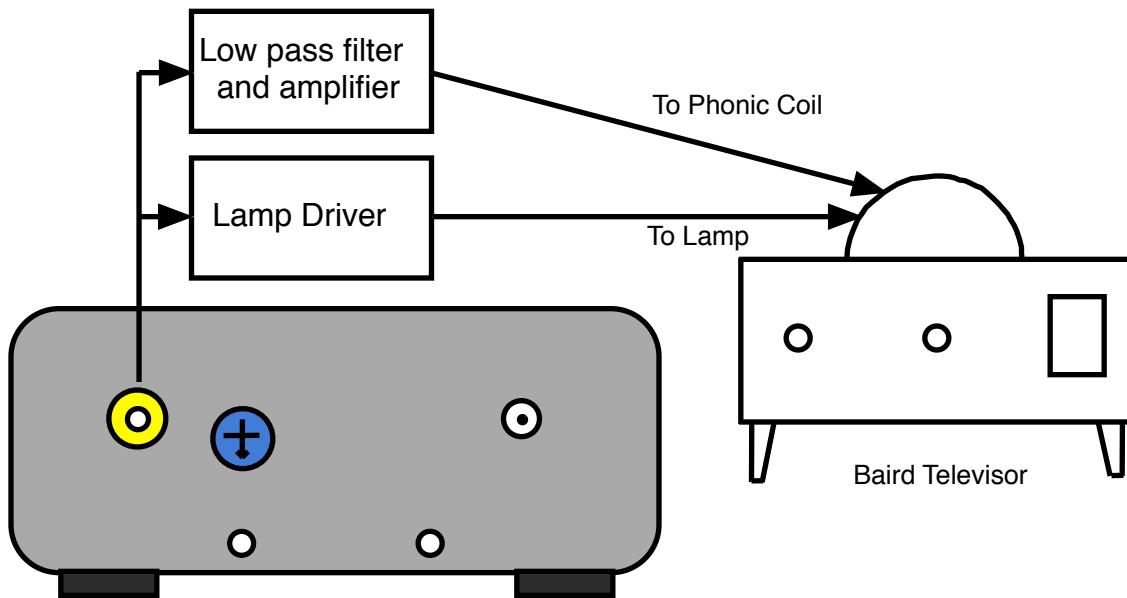
To help aid in setup, when no video input is presented to the converter, it will output a default image. This can be useful in making final adjustments to the television, and for phasing the television before the video input is connected.

Video content is important to consider when dealing with mechanical televisions due to the small size and low resolution of the image. Close ups that are centered in the video make for better viewing on the mechanical television. For standards with low aspect ratio such as Baird (3:7) and NBTV (2:3) only the center portion of the input video is converted to maintain the correct ratio.

Some examples of typical connections to mechanical televisions:



Example connection to Western Visionette using internal Current Driver



Example connection to Baird Televisor using external lamp driver and phonic coil filter and power amplifier

SCM-01D Current Driver Output:

When using the Current Driver Output of the SCM-01D converter, a few things need to be considered. Since this is a linear driver, excess heat may be generated in the converter. The unit is fully protected against thermal overload and will shut off the output if it reaches 65°C internally, and will not return to operation until the temperature falls back below 55°C.

To minimize heat dissipated by the driver, the voltage used to operate the converter should be no more than 2 volts above what is required by the LED you are using when driven at 333ma. For example, the NEL-1M requires approximately 10 volts to operate at 333ma, so you would run the converter at 12 volts maximum. Conversely you do not want to use too low of a voltage or clipping may occur in the output spoiling the image. It is recommended to keep the input voltage at least 1 volt above the operating voltage of the LED.

Theory of Operation

In order to convert between different video standards, spatial and temporal correction are required. Spatial correction involves changing the resolution, size and aspect ratio of the incoming video to the output video format. This can be easily achieved through standard digital methods utilizing scalers and FIR filters. This will be discussed in detail. Temporal correction involves changing the frame rate of the incoming video to match the outgoing video.

It was decided that no off the shelf components existed that would provide the desired functionality, so a FieldProgrammableGateArray, or FPGA, was chosen to provide all the digital functionality. By adding input/output circuitry, and ancillary circuitry to the FPGA, the entire system could be realized. The basic building blocks to the design are; FPGA, video decoder (ADC), and multiple power supplies. A brief description of each part follows:

FPGA: Xilinx XC3S250E-4VQ100
 250K gate equivalent
 216Kb block RAM
 1.2V Core / 2.5V Aux / 3.3V I/O

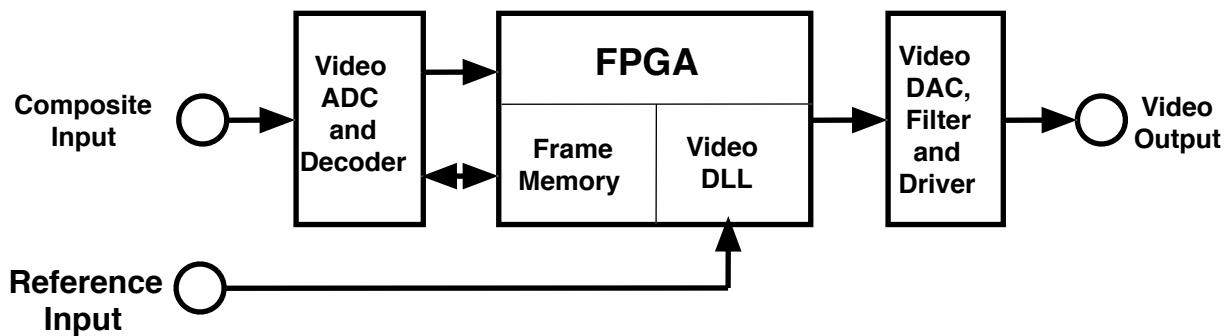
Video Decoder: TI TVP5150AM1
 9bit ADC's, 2X Over-Sampled
 Line Locked Clock
 4 Line Adaptive Comb Filter
 Multiplexed 8bit YCrCb output bus

Video DAC: Proprietary Design
 10bit effective DAC
 35 MSPS maximum conversion rate
 56 dB SNRs

FLASH Memory: Winbond W25Q80BV
 8Mb Serial FLASH ROM

Topology

A simplified block diagram of the circuitry is shown below:



The incoming video is digitized and processed by the TVP5150AM1 using a 14.318MHz reference crystal to the ITU-601 (formerly known as CCIR601) specification. All internal timing is generated using this crystal. The video is quantized, processed for brightness, contrast, chroma gain and hue, among others, and output at the ITU rate of 27MHz on an 8 bit, time multiplexed bus, with alternating luma and chroma samples. No other signals are required from this circuit as the ITU specification describes a method for encrypting the horizontal and vertical timing information directly into the digital data using timing reference makers, or TRS codes. A brief description of the ITU-601/656 specification is as follows:

Fundamental quantization frequency: 13.5MHz

Pixel Resolution: 720 H x 486 V NTSC / 720 H x 576 PAL

Image Aspect Ratio: 4:3

Pixel Aspect Ratio: 1.1 NTSC / 0.9 PAL

Horizontal Frequency: 15,734 Hz NTSC / 15,625 Hz PAL

Vertical Frequency: 29.97 Hz NTSC / 25 Hz PAL

Clocks per Line: 1716 NTSC / 1728 PAL (27MHz clock)

Clocks per Frame: 900900 NTSC / 1080000 PAL (27 MHz clock)

Note that the vertical frequency is 29.97Hz for NTSC, not 30Hz as expected. This is due to the NTSC color system that was first ratified in 1953.

Introduction

All monochrome television transmissions prior to this standard used exactly 30Hz, or 30 frames per second, so as to be in sync with the AC mains frequency. This is done to reduce distortions in the image due to induced AC fields or “hum” from the power supplies of these early sets. In order to devise a “compatible” color system that would show a monochrome signal on existing sets, RCA proposed a method of modulating the color components of the video signal onto a subcarrier in the video. For reasons beyond the scope of this manual, a frequency needed to be chosen so that no standing patterns in the color signal would result. This required lowering the vertical frequency from 30Hz to 29.97Hz. While this change caused no adverse side effects on televisions, it has created a legacy of problems for modern video equipment. Instead of being able to use integer numbers like 24, 25 and 30, we now have to include 29.97 which makes many calculations and conversion extremely difficult. For digital processing, the ratio 1000/1001 has been established as the conversion between 30 and 29.97 video.

The digital video data is then routed to the FPGA where it is further processed. The data is sent to the internal frame memories in round robin fashion. The frame memories are large enough to hold three frames of video, so there is always enough data to keep an uninterrupted flow to the output. The video data is scaled prior to storing in the field memories. This scaling is done with a multi-tap FIR filter for the horizontal downscaling, and averaging for the vertical. Extra processing like that to stretch the outer three pixels on each side of a Baird image is also done at this time.

All processing on the incoming video is done synchronous to the ITU clock. For the output clock, the 14.318MHz reference is used as a base. This frequency is then multiplied to increase it to 81MHz plus 4%. The additional 4% is used by the internal Digital Phase Locked Loop and will be discussed later. Using this clock, a video timing generator, or flywheel is created in the FPGA to generate all timing signals for the selected output standard. All line, frame, pixel count and line count generation is done in this process. This is the main “heartbeat” process for the entire design.

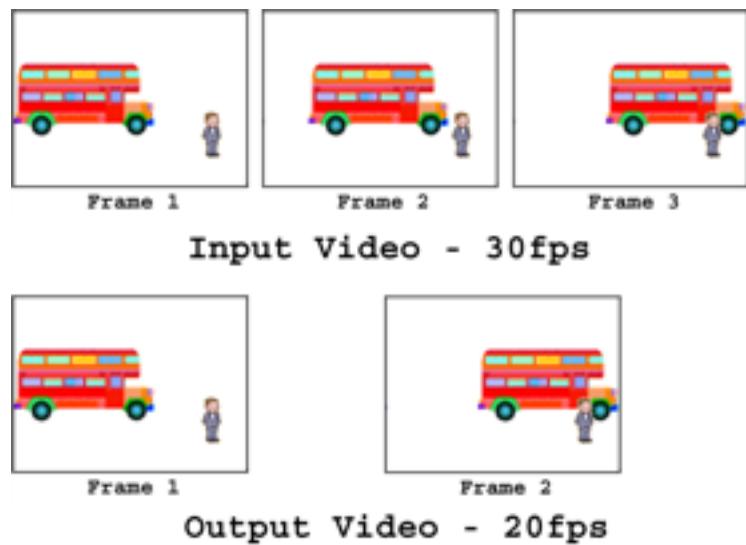
Using these timing signals, the video data that was stored in the frame memories synchronous to the incoming ITU video clock can now be clocked out.

With all the above timing now generated, the output video can be created. The signals from the flywheel are routed to the video output DAC at the appropriate times in the signal, while the processed video from the frame memories is routed to

the video DAC during the active portions of the video signal. The DAC is run at a three times over sampled rate to reduce filtering requirements, and increase SNR.

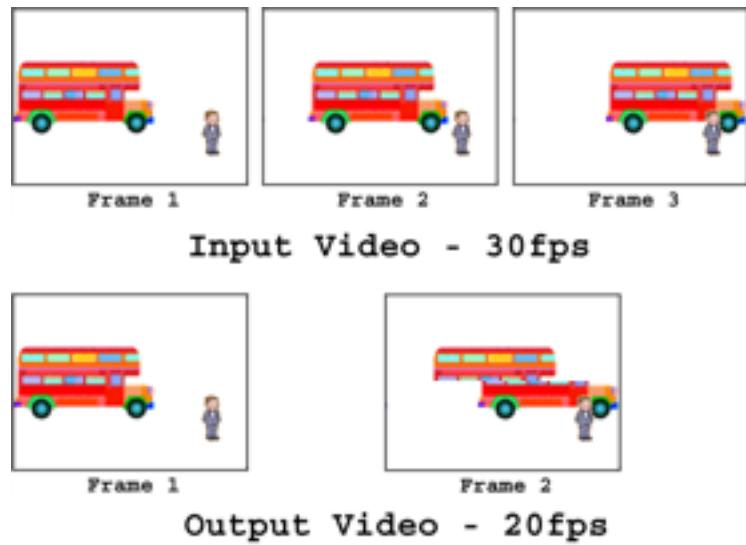
The video is then filtered and buffered before being sent to the video output connector.

During conversion, the unit provides two different methods for converting from the input frame rate (25 or 30fps) to the output frame rate (12.5 through 25 fps). In the first method, all three frame buffers are used, and images are only read out of a buffer after a new image has been entirely written into the buffer first. This provides good image quality with the drawback of jerky motion of fast moving images. This is due to the nature of duplicating or dropping frames on the input to match the output rate. Because a different number of frames can be dropped each time, the frames in the output video may represent frames that were say 1 or 2 apart in the original video. This can be shown graphically:



The closest frame in this example was the third one meaning the second one was dropped. The next time the second one may not get dropped meaning there is a difference in time between two output frames that is not consistent. This will only have an effect on fast moving objects.

Another method is to use just one frame buffer, and have the input and output writing and reading to it at the same time. This results in smoother output motion since the output image will change immediately when the input image changes. The drawbacks to this method are since the output image changes immediately, it may be in the middle, or anywhere in the image when the change takes place, and this position will change over time. This can be shown graphically:



In this example the new image being written into the buffer caught up with the image that was being read out of the buffer in the middle of the image. The “tearing” of the image is what results. Again, this will only have an effect on fast moving objects.

The user can select between the two above methods and choose the one that works best for them. Keep in mind the the frame rates of mechanical televisions are very low to start with, and fast motion will always look choppy now matter how the conversion is done. Standards like the 45/15-3i Western will benefit from the one buffer method since it is an interlaced format and will better utilize the finer temporal granularity.

It was briefly mentioned earlier in this section that the output clock is actually 4% above 81MHz. This is done to allow for a +/-4% lock range for the Reference Input. By implementing a sophisticated Digital Phase Locked Loop in the FPGA, the output clock can be frequency and phase locked to a reference clock. With 12ns step resolution, very fine adjustments are made to keep the output locked to the reference. This is done for standards that require an external reference like the 45/15-3i Western.

Hardware Setup and Test Mode

There is a hidden mode of operation that is used during initial setup and test of the converter that may be useful to some users. No harm can be done to the unit by simply entering this mode, but care should be taken if the following alignment procedure is attempted.

To enter the *Setup and Test Mode*, remove the power cable from the unit, While depressing the Auxiliary Button on the rear panel, reconnect the power supply to the unit. The Auxiliary Button must remain depressed until the front panel Status LED starts blinking. At this point the pushbutton may be released. The Status LED will repeat a pattern of two fast yellow flashes to indicate the unit is in the *Setup and Test Mode*. There are four different behaviors that can be selected. You can scroll through these by depressing the auxiliary pushbutton to increment to the next test in a round robin fashion.

Mode 1: This mode is used to observe and set the black level output of the converter when used with the optional internal Current Driver. This adjustment is not necessary when using an external Current Driver. When this mode is selected, the converter outputs video black. To adjust the black point of the Current Driver, momentarily short the Test Point TP1 inside the converter (must remove case lid) with a screw driver or similar tool. The Status LED will show two fast red flashes to indicate Black Level Setting Mode. This also forces the Black Level Control option to enabled during this test. Using the Options and Auxiliary Buttons, the level can be adjusted up or down, and should be set to where the Current Driver output is just coming on. This can easily be determined by viewing a connected LED for when the lamps just turn on. Once the desired level is obtained, momentarily short TP1 again to save the result in FLASH memory and return to the normal Test Mode. To exit this mode without saving the value, remove power from the unit.

Mode 2: In this mode, 100% white is output from the converter and can be used to verify the lamp driver is not clipping.

Mode 3: In this mode the default image is displayed.

Mode 4: This mode selects normal operation. This can be used to verify adjustments made in the prior modes on actual input video without having to leave the *Setup and Test Mode*.

Updating Firmware

If it ever becomes necessary to update the firmware in the unit, this can be accomplished through the internal programming port. The connector is a standard 8 pin, double row, 2mm connector. A custom cable with the appropriate mating connector is used in conjunction with an Asix Presto or similar programmer. A full description of the hardware, software, and procedure to FLASH the unit can be found in the supplemental programming guide for the converter.

Specifications

Video Input:

Supported Standards:	NTSC 29.97fps / PAL 25fps / SECAM 25fps
Video Quantization:	9bit A/D, 8 bit data
Video Input:	Composite - 1Vpp, 75 ohm impedance

Video Output:

Video Output:	1Vpp into 75 ohms
Video Quantization:	10 bit Effective D/A
Video Levels:	+/- 3%
Video SNR:	56dB typical

Reference Input:

Reference Input:	+/- 3.0V to +/- 30 V, 20K ohms impedance @ 50Hz, 60Hz and frame frequency
-------------------------	--

Current Output: (optional)

Current Output:	333 ma maximum, 14V maximum (12V recommended) Thermal protection at 65°C (hysteresis to 55°C) 2.5mm X 5.5mm connector
------------------------	---

General:

Dimensions:	2.60" X 2.60" X 1.00" (66mm X 66mm X 25mm)
Weight:	2.0oz (57g)
Power Requirements:	9Vdc typical, 7-14Vdc maximum 1.0 watts typical (Full Operation) 0.75 watt typical (Sleep Mode)
Humidity:	20% - 80% non-condensing
Temperature:	10C - 45C ambient (50F - 110F)

Supported Output Standards

0: 24/20p:

Image Aspect Ratios:	6:5
Active Pixels / Lines:	80 (cropped 90) / 24
Horizontal / Vertical Frequency:	20 Hz / 480 Hz
Scan Type:	Mechanical Progressive - Left to Right, Top to Bottom
Video Characteristics:	19.2 KHz, 100/0 video/sync ratio

1: 30/12.5p Baird:

Image Aspect Ratios:	3:7
Active Pixels / Lines:	120 / 36 (cropped 90, end 3 pixels stretched)
Horizontal / Vertical Frequency:	12.5 Hz / 375 Hz
Scan Type:	Mechanical Progressive - Bottom to Top, Right to Left
Video Characteristics:	22.5 KHz, 100/0 video/sync ratio

2: 30/12.5p TeKaDe:

Image Aspect Ratios:	4:3
Active Pixels / Lines:	90 / 30
Horizontal / Vertical Frequency:	12.5 Hz / 375 Hz
Scan Type:	Mechanical Progressive - Left to Right, Top to Bottom
Video Characteristics:	16.9 KHz, 100/0 video/sync ratio

3: 30/16.6p:

Image Aspect Ratios:	4:3
Active Pixels / Lines:	90 / 30
Horizontal / Vertical Frequency:	16.6 Hz / 500 Hz
Scan Type:	Mechanical Progressive - Left to Right, Top to Bottom
Video Characteristics:	22.5 KHz, 100/0 video/sync ratio

4: 32/12.5p NBTv:

Image Aspect Ratios:	2:3
Active Pixels / Lines:	32 (cropped 60) / 120
Horizontal / Vertical Frequency:	12.5 Hz / 400 Hz
Scan Type:	Mechanical Progressive - Bottom to Top, Right to Left 24.0 KHz, 70/30 video/sync ratio

5: 36/10p:

Image Aspect Ratios:	1:1
Active Pixels / Lines:	90 (cropped 120) / 36
Horizontal / Vertical Frequency:	10 Hz / 360 Hz
Scan Type:	Mechanical Progressive - Left to Right, Top to Bottom 16.2 KHz, 100/0 video/sync ratio

6: 39/12.5p:

Image Aspect Ratios:	4:3
Active Pixels / Lines:	90 / 39
Horizontal / Vertical Frequency:	12.5 Hz / 487.5 Hz
Scan Type:	Mechanical Progressive - Left to Right, Top to Bottom 21.9 KHz, 100/0 video/sync ratio

7: 45/15-3i Western:

Image Aspect Ratios:	1:1
Active Pixels / Lines:	90 (cropped 120) / 45
Horizontal / Vertical Frequency:	15 Hz / 675 Hz
Scan Type:	Mechanical Triple Interlaced - Right to Left, Top to Bottom 30.3 KHz, 100/0 video/sync ratio

8: 48/15p:

Image Aspect Ratios:	6:5
Active Pixels / Lines:	108 (cropped 120) / 48
Horizontal / Vertical Frequency:	15 Hz / 720 Hz
Scan Type:	Mechanical Progressive - Left to Right, Top to Bottom
Video Characteristics:	38.9 KHz, 100/0 video/sync ratio

9: 48/20p:

Image Aspect Ratios:	6:5
Active Pixels / Lines:	108 (cropped 120)/ 48
Horizontal / Vertical Frequency:	20 Hz / 960 Hz
Scan Type:	Mechanical Progressive - Left to Right, Top to Bottom
Video Characteristics:	51.8 KHz, 100/0 video/sync ratio

A: 48/25p:

Image Aspect Ratios:	4:3
Active Pixels / Lines:	120/ 48
Horizontal / Vertical Frequency:	25 Hz / 1200 Hz
Scan Type:	Mechanical Progressive - Left to Right, Top to Bottom
Video Characteristics:	72.0 KHz, 100/0 video/sync ratio

B: 50/25p:

Image Aspect Ratios:	4:3
Active Pixels / Lines:	120/ 50
Horizontal / Vertical Frequency:	25 Hz / 1250 Hz
Scan Type:	Mechanical Progressive - Left to Right, Top to Bottom
Video Characteristics:	75.0 KHz, 100/0 video/sync ratio

C: 60/12.5p Baird:

Image Aspect Ratios:	3:7
Active Pixels / Lines:	120 / 72 (cropped 180, end 6 pixels stretched)
Horizontal / Vertical Frequency:	12.5 Hz / 750 Hz
Scan Type:	Mechanical Progressive - Bottom to Top, Right to Left
Video Characteristics:	45.0 KHz, 100/0 video/sync ratio

D: 60/20p:

Image Aspect Ratios:	6:5
Active Pixels / Lines:	108 (cropped 120)/ 60
Horizontal / Vertical Frequency:	20 Hz / 1200 Hz
Scan Type:	Mechanical Progressive - Left to Right, Top to Bottom
Video Characteristics:	64.8 KHz, 100/0 video/sync ratio

E: 60/25p:

Image Aspect Ratios:	6:5
Active Pixels / Lines:	120/ 60
Horizontal / Vertical Frequency:	25 Hz / 1500 Hz
Scan Type:	Mechanical Progressive - Left to Right, Top to Bottom
Video Characteristics:	90.0 KHz, 100/0 video/sync ratio

Available Models

Model No. SCM-01

NTSC/PAL to 24/20p through 60/25p output standards

Model No. SCM-01D

NTSC/PAL to 24/20p through 60/25p output standards with internal current driver

Firmware Revision History

Revision 4.0, October 2, 2012:

- 1) New hardware revision based on 4.x hardware now incorporates FPGA firmware, factory parameters, user parameters and user default image into a single serial FLASH ROM.
- 2) Added 36/10p standard.

Revision 3.2, March 12 2011:

- 1) Changed behavior of the Black Level control. When enabled, this forces the black level of all standards to be set to 30% and peak white set to 100%. This is used when the internal current driver is used.

Revision 3.1, December 5, 2009:

- 1) Changed behavior of the Reference Input. When supplied with a 50Hz or 60Hz input, the video output will now adapt it's base frequency to match. For instance with a 60/20p standard and a 60Hz reference, the video output will be 60/20p and frequency/phase locked to the reference. If a 50Hz reference is used, the output will now be 60/15p and will still be frequency/phase locked to the reference. This change was made due to the nature of AC synchronous motors. If a television that was designed to use 60Hz mains is used on 50Hz mains, it will run 20% slower and vice-versa. The converter will now allow televisions designed for one part of the world to work in another part with different AC mains frequency.
- 2) A Reference Hold option was added to make the output track the last reference input even after it has been removed.

Revision 3.0, November 7, 2009:

- 1) New release based on new 3.x hardware.
- 2) Multi-standard capable up to 16 unique formats.
- 3) Reference input added for synchronizing to an external reference signal.
- 4) Improved image scaling algorithms.
- 5) Improved default image.
- 6) Optional internal LED Current Driver board.

Firmware Revision History

Revision 1.0, April 23, 2007:

- 1) Initial release.

Note: Hardware/Firmware revision level can be found on bottom label of unit.